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Landfarm Technology at Fort Polk, Louisiana: Lessons Learned

by
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Changes in Louisiana's Solid Waste Rules and Regulations have ended the practice of disposing of contaminated soil in the landfill at Fort Polk. Regulations have also affected the disposal of sewage sludge from the installation. The projected costs for proper disposal of contaminated soils and sewage sludge led the Environmental and Natural Resources Management Division at Fort Polk to look at alternative and/or new disposal technologies. One such technology is landfarming, a treatment process in which waste is mixed with the surface soil and is degraded, transformed, or immobilized.

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FOREWORD

This work was performed by the Environmental and Natural Resources Management Division, Fort Polk, LA, in conjunction with the U.S. Army Construction Engineering Research Laboratories (USACERL) Environmental Division (EN) under MIPR FE-0689, dated September 1989. The Fort Polk technical monitor was Dr. Charles Stagg (AFZX-DE-E).

Jackie L. Smith, an agronomist, serves as a Supervisory Environmental Scientist, and James D. Graf[illegible] is an Environmental Protection Specialist at Fort Polk. Appreciation is expressed to Dr. Charles Stagg, Chief Environmental and Natural Resources Management Division, Fort Polk, for the help and guidance provided during this study. Dr. Diane Mann, USACERL-EN, was the principal investigator. Dr. Ed Novak is the Acting Chief, USACERL-EN. The USACERL technical editor was Gloria J. Wienke, Information Management Office.

COL Daniel Waldo, Jr. is Commander and Director of USACERL, and Dr. L.R. Shaffer is Technical Director.

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LANDFARM TECHNOLOGY AT FORT POLK, LOUISIANA

1 INTRODUCTION

Background

Fort Polk, LA, is located in central Vernon Parish in West-Central Louisiana, about 6 miles southeast of the town of Leesville. In early 1983, a combination of factors prompted Fort Polk to explore alternatives for disposing of sewage sludge and contaminated soil. Changes in Louisiana's Solid Waste Rules and Regulations ended the practice of disposing of contaminated soil in the installation's landfill. Changing regulations were also affecting the disposal of sewage sludge. Previously, sewage sludge had been used along roads and in wildlife food plots, but a proposed state environmental regulation was going to require a solid waste permit for each area used for sludge disposal. The projected costs of proper disposal for contaminated soils and sewage sludge under the new regulations were the impetus for looking at alternative and/or new technologies.

The technology investigated in this research is landfarming, a treatment process in which waste is mixed with the surface soil and is degraded, transformed, or immobilized. The surface soil is used as the treatment medium and the process is based primarily on the principle of aerobic decomposition of organic wastes. Compared to other land disposal treatments such as landfills and surface impoundments, landfarming has the potential to reduce monitoring and maintenance costs, as well as cleanup liabilities. Because of these reduced costs and liabilities, and the relatively low initial and operating costs, landfarming has received much attention as an ultimate disposal alternative.

The Environmental and Natural Resources Management Division at Fort Polk asked the U.S. Army Construction Engineering Research Laboratories (USACERL) to assist with the landfarm project. The project is documented in this report because the technology may be of interest to other Army installations.

Objective

The objective of this report is to document landfarm technology as it was used to treat contaminated soil and sewage sludge at Fort Polk, LA.

Approach

The activities involved in site selection and the solid waste permitting process are discussed in Chapters 2 and 3, respectively. Landfarm operations and environmental monitoring are discussed in Chapters 4 and 5, respectively. Based on the successful operations as reflected by monitoring data, Fort Polk applied for and received a solid waste permit modified to allow recycling of the degraded material from the landfarm (Chapter 6). Chapter 7 contains lessons learned during this project and suggests some applications.

2 LANDFARM SITE

Site Selection

Site selection for a proposed landfill/landfarm complex at Fort Polk began in 1983. The complex would operate according to a solid waste permit issued under new Louisiana Department of Environmental Quality (LADEQ) Solid Waste Rules and Regulations. An area west of Chaffee Road and north of the intersection with Mill Creek Road was tentatively selected. This tentative selection was based on visual observations; clay soils were visible on the surface and plants indicative of heavy soils (hawthorn, native crabapple, and post oak) were abundant.

The U.S. Army Corps of Engineers, Fort Worth District, carried out the geohydrologic testing of the site. Borings were made on a 300 ft x 300 ft* grid to collect soils, geologic, hydrologic, permeability, and other site information. An isometric profile was created from the correlation of continuously sampled borings to depths of 40 to 50 ft, which is a minimum of 20 ft below the lowest proposed excavation point. Borings subsequently were backfilled with a cement-bentonite-water mixture to prevent contamination of groundwater.

Groundwater

The general direction of groundwater flow at the site is south. No water wells are operating, abandoned, or proposed within 1 mile of the site perimeter. Four freshwater aquifer units are located under the site at depths ranging from 480 to 1570 ft.

Surface Drainage

The landfarm site is completely outside of the 100-year floodplain. Surface drainage outside the landfarm is drained away from the site.

Geological Characteristics

The landfarm site is on an outcrop of a clay formation approximately 360 ft thick. Overburden at the site consists of a mantle of residual soil that is brown to light brown, very stiff, calcareous clay of high plasticity with minor amounts of sand. Frequently, it contains organic material. This soil averages 2 ft thick and covers the entire site.

Primary material underlying the overburden consists of very stiff to hard clay of high plasticity. It contains scattered lime nodules in varying concentrations and minor amounts of silt, fine sand, and carbonaceous material. Structurally, the clay is massive with scattered lenses and pockets of clayey silt, silt, and fine sand. Tight slickensides (polished, smoothly striated surfaces resulting from slippage along a fault plane) occur with moderate frequency and appear to be confined to clay zones of higher plasticity.

Environmental Characteristics

There are no known historical sites, recreational areas, archaeological sites, designated wildlife management areas, swamps, marshes, habitat for endangered species, or other sensitive ecological areas within 1000 ft of the site.

* A metric conversion table is on page 18.

After analysis of the preliminary data, it was determined that the site met the criteria of the State of Louisiana for the siting of landfills and landfarms. Once this determination was made, the Fort Worth District prepared the application for a solid waste permit (see Chapter 3).

Construction

Construction of the facility began in late 1984. The site was cleared by shearing using a KG blade on a D-8 bulldozer. Shearing left the stumps and roots, which had to be grubbed using rippers on a large motorgrader. Grubbing was on 24-in. centers to a depth of 18 in.

The pond embankment and enclosing levee were constructed of material taken from an adjacent location. Clay soils used in constructing the pond embankment are characterized as containing slickensides. Soils having this characteristic are minimally acceptable for this use and may slump after several years, causing a maintenance problem.

A buffer zone of approximately 100 ft was created between the landfarm operational area and its boundary fence. This buffer area consists of a strip of cleared land and a strip of trees near the perimeter fence of the landfarm.

Layout and Security

Total area of the facility is 8.26 acres, which is enclosed by levees. Of the total area, 3 acres in the southeast corner are reserved for impoundment runoff. The landfarm usable area is 4.1 acres, subdivided into four working plots separated by a terrace (diversion), which reduces sheet flow and prevents the migration of material being degraded. All runoff water diverted by the terraces is dumped into a common grassed waterway and flows into the impoundment. Figure 1 is a diagram of the landfarm complex.

The surface impoundment was designed to retain rainfall/runoff from the landfarm area and as an irrigation water supply source. It was created by constructing an earthen embankment along the southern and eastern boundaries of the landfarm. A levee was installed along the northern and western boundaries of the landfarm to intercept and prevent offsite surface water from entering the area. To prevent overtopping of the embankment surrounding the impoundment, an emergency spillway was constructed. Sufficient natural clay is present to meet the thickness requirements of the barrier along the bottom and sides of the impoundment. Five groundwater monitoring well sites (three downgradient and two upgradient) were installed to assure that probable contaminant flow paths are monitored.

The east boundary of the landfarm is more than 100 ft from Chaffee Road, a major traffic route. Dense native vegetation of mixed pine and hardwood forest was left between the perimeter fence of the landfarm and Chaffee Road. The north and west boundaries of the landfarm are a common boundary with the sanitary landfill. The south boundary is undeveloped forest area.

Security of the landfill site is assured by a boundary fence of three-strand barbed wire with a single access point secured by lock and key. Signs are placed on the fencing to help prevent inadvertent entry by unauthorized personnel.

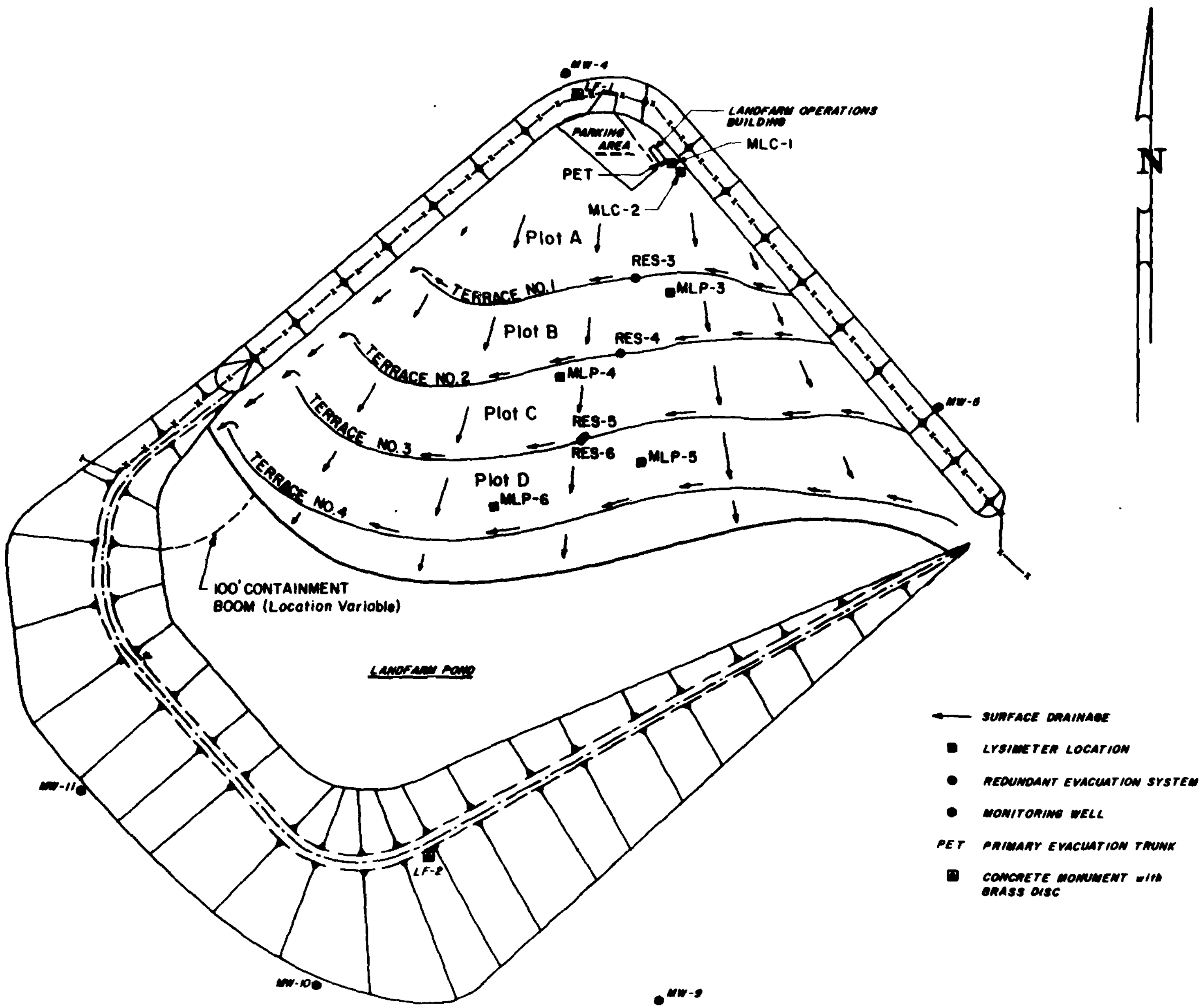

Figure 1. Fort Polk Landfarm Layout.

3 PERMITTING

Initial Permit Proposal

Before construction of the landfarm was completed in the late spring of 1985, resources and efforts had already been directed toward obtaining a joint solid waste permit for the landfarm and adjacent landfill site. The State of Louisiana would not consider a joint permit application. Consequently, the landfarm was permitted as a single entity. The Forth Worth District was contracted to prepare the application for a Solid Waste Landfarm Permit.

Permit Part I, a form from the Louisiana Department of Natural Resources Office of Environmental Affairs, was submitted in February 1985. Permit Part II, documentation of the proposed landfarm site and its operation, was completed in June 1985 and revised in October 1985. Major sections included in Part II were a master plan, facility specifications, an operational plan, an implementation plan, a monitoring plan, post closure data, and financial responsibility statements.

In addition to the site data (Chapter 2), information gathered for the Part II documentation included a "wind rose" from hourly wind data collected between January 1967 and 1976, and rainfall frequency.

Permit Limits

Like any solid waste permit, a landfarm permit will vary from state to state. However, this landfarm permit addressed security, safety/emergency situations, hydrological/drainage characteristics, geological/soil characteristics, environmental characteristics, facility plans and specifications, monitoring and operational procedures, and recordkeeping and closure information.

The Fort Polk landfarm permit detailed total weekly application rates for various wastes (oily-429 lb/acre, grit 1.1 cu yd/acre, and dried sludge 1.9 cu yd/acre). The method of application, recordkeeping systems, key personnel, training, and hours of operation were also specified. Extensive attention was given to the expansion of the Fork Polk's Installation Spill Contingency Plan (ISCP) to ensure safety/emergency requirements were satisfied. Prevention of salvaging and scavenging were also addressed along with other security measures.

4 OPERATIONS

Operation of the landfarm began in January 1986 after approval of the permit application. A control building with truck scales is located on the adjacent landfill property near the landfarm access point. All vehicles admitted to the landfarm are weighed. Weight tickets are accumulated and a landfarm operator picks up the records daily. Records are maintained at the Environmental and Natural Resources Management Division.

Personnel

The landfarm is operated by two people certified by the State of Louisiana as Class A landfarm operators. These people are responsible for all aspects of operation—both administration and labor. One additional operator has Class C certification and conducts only labor activities. The responsibilities of daily operation are rotated among the operators.

Training

A training program was established for all government employees involved in waste collection, transportation, and disposal. Training included the following subjects: recordkeeping, security, emergency procedures (including the Installation Spill Contingency Plan [ISCP]), landfarm operations (including limitations, equipment, irrigation, waste application, turfing, and landscape maintenance), inspection requirements, and leachate and vector control.

Loading

Fort Polk operates two waste water treatment plants; one at North Fort Polk and one at South Fort Polk. The North Fort plant has 4 operational digested sludge drying beds and the South Fort plant has 18 drying beds. The combined annual production of digested sewage sludge from both treatment plants is approximately 525 tons. Additionally, two drying beds at the South Fort wastewater treatment plant are used as the accumulation point for soil contaminated by petroleum, oils, and lubricants (POL) and for washrack sediments.

When the drying beds are cleaned, POL-contaminated soil, washrack sediments, or digested sewage sludge is loaded into dump trucks using a hydraulic, telescoping boom loader. The trucks travel approximately 5 miles to the landfill scales where they are individually weighed; the weights are recorded by truck number. The trucks then proceed to the landfarm, a distance of about 250 yards.

Trucks are positioned and dumped by the landfarm operator on duty. Each load is dumped so there is no travel through previously offloaded material. This prevents tracking of contaminated soil/sediments and sludge out of the landfarm.

Normal operations dictate that either all of the POL-contaminated soil/sediments or all the digested sewage sludge be transported and dumped at the landfarm before transporting and dumping the other material. The material received first is spread across the plot of application. Upon completion of the initial loading, the second material is brought in and dumped on top of the previously applied material. It is also spread to provide a uniform depth and loading across the entire plot. The material is then mixed using a windrow procedure. A crawler tractor, equipped with a four-way tilt blade, rolls both layers of

material into a windrow, then rolls the windrow back into the area originally occupied and spreads the material over the entire plot.

During off-loading, initial spreading, and mixing, all foreign objects (inorganics) are removed. The objects are accumulated in the bucket loader attachment of the tractor, weighed, and taken to the landfill for disposal. The weight of the foreign material is subtracted from the total weight of waste received. After spreading operations are complete, the crawler tractor used in this operation is cleaned on site with water from the impoundment using an irrigation pump as a power washer.

Use of standard farming equipment and other equipment (Table 1) helped reduce operational costs.

Degradation

The waste mixture is further mixed using the farm tractor and disc harrow. A few passes of the disc harrow with the cutters set almost straight helps locate any foreign objects missed during the initial screening. The cutters are then angled and the waste is mixed to maximum cutter depth.

Tilling is normally performed twice daily for the first 2 weeks using the PTO-driven roto-tiller. Frequency of tillage is weather dependent, and is performed as conditions permit during periods of inclement weather.

Occasionally, the digested sewage sludge has not completely dried; this dictates a number of minor operational changes because (1) the crawler tractor cannot mix and spread the material easily; it flows ahead of the blade; (2) the sludge behaves as a lubricant and reduces traction.

Table 1

Equipment List

1	Rubber tired tractor, John Deere 2550 w/bucket loader attachment
1	Disc harrow, TPH, 6 foot, 20 cutter
1	Roto-tiller, 6 foot, TPH, PTO-driven
1	Seeder/spreader, 800 lb capacity, TPH, PTO-driven
1	Ag Rain irrigation system, reel type, traveling sprinkler
1	Peg-tooth harrow, TPH, 10 foot
1	Box Blade, TPH, 6 foot
1	Rotary mower, TPH, PTO-driven, 6 foot
1	Vacuum pump (for evacuating soil pore water lysimeters)
1	Portable pump generator (to energize vacuum pump)
3	Fixed rain gauges
3	Movable rain gauges (for measurement of irrigation water)

TPH = three point hitch
PTO = power take off

All farm equipment is manufacturer's standard equipment readily available from any farm equipment/implement dealer. Other equipment is also readily available from appropriate dealer/supplier. Commercial or trade names are cited for illustrative purposes. Neither the United States Government nor any agency thereof make any endorsement concerning the products.

This listing includes only equipment dedicated exclusively to landfarm operations.

If wet sludge is encountered, the crawler tractor is tracked back and forth through the material. Ruts created expose a larger surface area which speeds up the drying process. The rutting/drying process is continued, using the farm tractor, until the tractor can travel in a straight path when the tiller is attached. When the material has dried sufficiently, normal twice per day tilling is resumed.

Throughout the degradation cycle, irrigation, if required, is performed after tillage or on days when there is no tillage. Maximum microbial activity is encouraged if the waste mixture is never allowed to completely dry at any time during the degradation cycle. Approximately 1 in. of irrigation water per week is required at Fort Polk during periods of little or no rainfall. Table 2 shows the typical degradation cycle.

At the end of the first 4 weeks of intensive tillage, the interval is reduced to three times per week and tillage is continued for the next 4 weeks. Between the 8th and 10th weeks, a preliminary phytotoxicity test is performed to determine the intensity of future tillage. Prior to seeding, the soil/waste mixture is fertilized at a rate that will yield 32 lb actual nitrogen, 32 lb actual phosphorous, and 32 lb actual potassium per acre. Fertilizer is broadcast and incorporated into the soil/waste mixture. The soil/waste mixture is seeded with a rapidly germinating plant, browntop millet, at a rate of 35 lb per acre. The top of the mixture is slightly compacted to aid germination. If required, plots are irrigated every other day.

In Louisiana, browntop millet will normally germinate within 3 to 4 days and grow to a height of 2 to 4 in. within a week. If the planting exhibits acceptable establishment and growth, it is incorporated into the soil (per the permit requirements) by tilling and a tilling schedule of once per week is followed for approximately 12 to 14 weeks. Should the planting show diminished plant establishment or stunted, chlorotic plants, the planting is incorporated into the soil and a schedule of 3 times per week tillage is resumed. The preliminary phytotoxicity test is repeated at 2-week intervals until successful. Tillage is then reduced to once per week for the remainder of the degradation cycle.

After the reduced tillage increment, a final phytotoxicity test is performed using plants of the genus Brassica. Planting rates will vary according to species selected. The procedure is the same as for the preliminary test. If the test is not successful, tillage is resumed and the test is repeated periodically until successful.

Once a final phytotoxicity test is successful and all other permit requirements are met, the degraded material can be removed from the landfarm and used according to modifications to the permit (see Chapter 6).

Surface Impoundment

The surface impoundment is inspected weekly and after storms to detect evidence of deterioration of the levees, overtopping, malfunctions, or improper operation. If a leak is detected, the LADEQ Solid Waste Management Division is notified immediately.

Water in the surface impoundment is used to irrigate the landfarm plots when rainfall is limited. It is also used to clean equipment. This practice reduces the amount of material tracked off the site. It also eliminates the use of fresh water on the site and assures control over the washwater.

Table 2

Typical Degradation Cycle at Fort Polk, Louisiana

Sequence	Week After Loading 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Initial Loading Date (NLT 1 April)														
Tillage/Aeration 2/day	•	•												
Tillage/Aeration 1/day*			•	•										
Irrigation (as required)	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Tillage/Aeration 3/week					•	•	•	•						
Preliminary Phytotoxicity Test (Browntop Millet)									•					
Tillage/Aeration 1/week										•	•	•	•	•
Final Phytotoxicity Test (Brassica Species)														
Soil/Waste Mixture Sampling												•		
Fertilization									•					

Sequence	Week After Loading 15	16	17	18	19	20	21	22	23	24	25	26
Initial Loading Date (NLT 1 April)												
Tillage/Aeration 2/day												
Tillage/Aeration 1/day*												
Irrigation (as required)	•	•	•	•	•	•	•	•	•	•	•	•
Tillage/Aeration 3/week												
Preliminary Phytotoxicity Test (Browntop Millet)												
Tillage/Aeration 1/week	•	•	•	•	•	•	•	•	•	•		
Final Phytotoxicity Test (Brassica Species)											•	•
Soil/Waste Mixture Sampling												•
Fertilization											•	

* Assuming receipt of dry digested sewage sludge.

5 MONITORING

The permit requires monitoring of groundwater, soil pore water, *in-situ* soils, soil/waste mixture, surface water impoundment, and plant growth. Baseline analyses were made for groundwater and soils before introducing wastes into the facility. Operational analyses are compared to baseline data after each sampling episode. All groundwater monitoring wells, soil pore water lysimeters, and the surface impoundment are sampled and analyzed semi-annually for iron, chloride, specific conductance, pH, total organic carbon, total dissolved solids, nitrate, and total nitrogen. Soil pore water is monitored by glass block lysimeters. Two are located outside the application area and four are located within the area of waste application. In addition to the analyses stated for groundwater, soil pore water is analyzed for nickel, cadmium, copper, zinc, and lead.

In-situ soil with which wastes will be mixed are sampled before application of wastes. Two areas within each plot are randomly selected and sampled at the depth of 0 to 6, 6 to 12, 12 to 24, and 24 to 36 in. Each sample interval is analyzed for cation exchange capacity, pH, total nitrogen, organic matter, salts (calcium, magnesium, sodium, aluminum, iron), nickel, cadmium, copper, zinc, and lead. The soil/waste mixture is sampled immediately after initial mixing and near the middle and end of the degradation cycle. Samples are collected from two areas of each plot and are analyzed for the same parameters as the *in-situ* soils.

Agronomic monitoring is accomplished by phytotoxicity testing and plant tissue analyses. (Phytotoxicity testing is discussed in Chapters 4 and 6.) Plants from the final phytotoxicity test are collected and analyzed for nickel, lead, copper, zinc, and cadmium. All analyses to date have shown no uptake of these metals.

Analytical results are reported to LADEQ annually. All test results have been within limits set by LADEQ Solid Waste Rules and Regulations and no deficiencies have been found during quarterly on-site inspections by LADEQ inspectors.

6 RECYCLING

Permit for Recycling

At the time the permit was prepared, the possibility of recycling the degraded material was not considered. The permit required the facility to have a finite lifespan; operations would cease on 1 November 1993 and have a final closure date of 1 April 1994.

Phytotoxicity testing had been conducted since completion of the first degradation cycle and the plants were very responsive to the degraded mixture. This testing was not required by the permit application but was initiated as a mechanism to determine the completeness of the degradation cycle. Plant tissue sample analyses had shown that plants growing on the degraded material did not uptake heavy metals when compared to the control sample data. Based on these and other indicative analytical data, it was decided to request a permit modification that would allow reuse of the degraded material.

It was proposed to the LADEQ that the degraded material be removed from the facility after certain conditions had been met. First, the soil/waste mixture would undergo degradation in the plots for a period of not less than 6 months and the degradation cycle would be concluded only when (1) heavy metals were below threshold values, defined in Louisiana Solid Waste Rules and Regulations, in the degraded material matrix, (2) organic matter content of the degraded material was at least 3 percent over native soil, (3) degraded material texture (U.S. Department of Agriculture classification) by field determination was sandy loam or finer, and (4) a successful field growth test (phytotoxicity test) of the degraded material had been completed using plants affected by petroleum waste application, such as the genus Brassica.

It was also proposed that factors to be evaluated during field growth testing would be (1) germination, (2) plant vigor, (3) uniformity, and (4) response to nutrients. A rating scale of 0 (none) to 5 (good) would be used and rating of all factors must be 3 or greater before the field growth test could be considered successful and the degradation cycle concluded.

It was also proposed that all field growth testing and evaluation be performed by an agronomist and, at the end of the degradation cycle, the treated material would be removed from the facility and used as an amended topsoil for establishment of vegetative cover on the active landfill and a closed landfill. These sites were chosen because they are within controlled access areas that are monitored under provisions of the State of Louisiana Solid Waste Rules and Regulations.

The closure plan was also addressed and it was proposed to delete stated closure dates and substitute the following closure plan: (1) landfarm operations will cease if maximum applied metals in the upper 12 in. of the *in-situ* soil with which the waste will be incorporated reach limitations specified by the State of Louisiana Solid Waste Rules and Regulations; (2) date of final closure will be determined by limitations specified in (1) above. The Assistant Secretary LADEQ will be notified immediately if specified limitations are reached. Notification will include the actual or proposed closure date.

These proposed modifications were presented to the State of Louisiana, Department of Environmental Quality in early June 1989 and approval was granted in early November 1989. Degraded material is now being removed and used in accordance with provisions of the permit application.

Effects of the Permit Modification

The modified permit:

1. Allows the Fort Polk landfarm to better comply with the intent of the Resource Conservation and Recovery Act (RCRA) which stresses alternatives, such as recycling, to disposal.

2. Allows the facility to become a recycle facility with an indefinite lifespan, rather than being a disposal facility with a finite lifespan.

3. Provides an amended topsoil/soil amendment for establishing vegetative cover on the active and closed landfill, which will minimize soil migration and improve integrity of the capped areas.

4. Delays closure of the facility indefinitely; closure is dictated by reaching certain threshold values rather than a stated date whether or not the assimilative capacity of the facility has been reached.

5. Reduces the cost of offsite disposal. Table 3 lists the estimated costs Fort Polk would have paid for offsite disposal based on the actual weight of soils and sludge disposed of at the landfarm. In addition to the tipping fees for pure disposal, the offsite costs include contract and operational costs for a commercial hauler. By using landfarm technology, Fort Polk has reduced pure disposal costs to almost zero. The installation still must cover the costs of onpost transportation and administration, but tipping fees are no longer an operating cost.

Table 3

Estimated Costs for Offpost Disposal of POL Contaminated Soils (POLCS) and Digested Sewage Sludge (DSS) in Louisiana

Time Period	Weight (tons)	POLCS/DSS Classification	$ Amount
Jan 87 - Jun 87	333.20	POLCS	44,982.00
	900.00	DSS	121,500.00
Jul 87 - Jun 88	1055.10	POLCS	142,438.50
	795.09	DSS	107,337.15
Jul 88 - Jun 89	1792.80	POLCS	242,028.00
	350.00	DSS	47,250.00
Jul 89 - Jun 90	1659.94	POLCS	224,091.90
	583.51	DSS	78,773.85
Jul 90 - Jun 91	727.63	POLCS	98,230.05
	0	DSS	-
	Grand Total through Jun 30, 1991:		$1,106,631.45

7 SUMMARY AND LESSONS LEARNED

Summary

The landfarm technology discussed in this report is a practical and successful method of treating contaminated soil and sewage sludge at Fort Polk, LA.

Site selection included evaluation of groundwater resources, surface drainage, and geological and environmental characteristics. The facility is enclosed by levees that prevent offsite water from entering the area and that retain rainfall/runoff from the landfarm area. The water in the surface impoundment is then used for irrigation and to clean equipment used on the site. The site is also enclosed by a three-strand barbed wire fence to help prevent unauthorized entry.

Because the original permit for a combined landfill/landfarm complex was not approved by the State of Louisiana, the landfarm was permitted as a single entity. Based on the results of monitoring during operation, Fort Polk applied for and was granted a permit modification to allow recycling of the degraded material from the landfarm. The material is now removed from the facility and used as a soil amendment on the active adjacent landfill and a closed landfill.

Lessons Learned

Using offsite borrow for the pond embankment resulted in a pond with a very shallow side. Overgrowth of vegetation is becoming a problem. Storage capacity of the impoundment would have been increased and the vegetation problem reduced if this side were deeper. This factor should be considered during the planning/construction phases at other landfarms.

Initially, it was determined that loading would be done in 10-ft wide contoured strips within each plot. This proved to be impossible. Positioning trucks for unloading is very difficult, and when material was spread to an even thickness it would often be moved outside the strip. An amended layout and loading procedure is recommended for other landfarms.

The permit initially allowed grasses (bermuda, bahia, ryegrass) which are very tolerant to hydrocarbons to be planted on the degraded material. This was changed to plants that are sensitive to and are affected by petroleum wastes. This gives a more accurate indication of completeness of degradation. The use of species sensitive to petroleum/hydrocarbons is recommended at other landfarms.

A carbon-nitrogen ratio of 10:1 in the soil/waste mixture should be maintained as nearly as possible/practical for efficient degradation.

Equipment used should be cleaned on site.

For best initial spreading, a crawler tractor is used. Later spreading is fine-tuned using a box blade and rubber-tired tractor.

At the beginning of operations, soil/waste mixture samples were composited by plot. The composite yielded only a single value and did not reflect the range of values that occurs in the mixture. Several samples from separate locations within the plot should be taken to establish a range of parameter values for the soil/waste mixture.

Applications

Potential Army-wide benefits from the landfarm method used at Fort Polk include:

- The use of naturally occurring microbes allows landfarming to be conducted in various climates.

- The use of standard farming and other equipment improves equipment accessibility and helps maximize cost savings.

- A variety of control/test methods can be used to satisfy local and state environmental concerns and regulations.

- The cost benefits of operating a landfarm versus paying for offsite disposal are easily quantified.

- Operating a landfarm in a recycling mode of operation offers the possibility of long term financial benefits.

METRIC CONVERSION TABLE

1 acre	=	0.405 hectare
1 cu yd	=	0.765 m^3
1 ft	=	0.305 m
1 in.	=	2.54 cm
1 lb	=	0.454 kg
1 mi	=	1.61 km
1 yd	=	0.914 m
1 ton	=	907.2 kg

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